FLIPPED LEARNING – INNOVATIVE, PEDAGOGIC APPROACH IN EDUCATION OF MECHANICAL ENGINEERING STUDENTS

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Abstract

In times of transformation to Industry 4.0 the requirements to develop competencies 4.0 and the needed skills are becoming more and more demanding. Academia faces a number of challenges to tune programs and curriculums in order to satisfy the needs of the companies. New and innovative pedagogic approaches are needed not so much in the introduction and first level subject courses, where basic technical knowledge is delivered. However, in the third year, for the advanced subject and project courses they are critical for achieving the objectives of the courses and developing the competencies required by the industry of tomorrow.
The authors of this paper are teachers of a course – Product design and development - and they are members respectively to Mechanical Engineering department and Design department. In the paper, an overview of innovative pedagogical methods and approaches applied in educating mechanical engineering students is presented. In addition, an example with shifting the classroom teaching to flipped learning applied in the course Product design and development is given. The outcome of this shift will be represented by the result in the course and the analysis of a survey, where data was gathered from the students in the course.

Keywords: *Industry 4.0, competences 4.0, innovative pedagogic approaches, flipped learning.*

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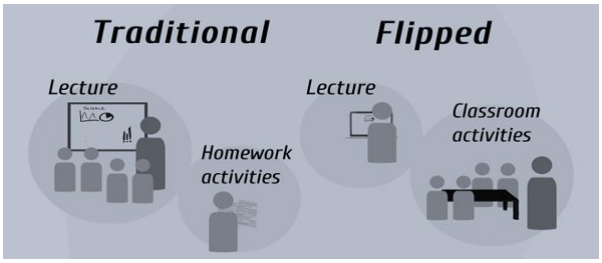
1. Introduction

In a dynamic world that is forever undergoing economical, societal, environmental and political changes, the higher education sector in general and the engineering discipline in particular remain under constant pressure to meet the continuous demands of the industry that is in need of highly intellectual graduates with the relevant cognitive and experiential skills. Such dynamics and demands, paired with the fast growing and rapid advancements of technology at the dawn of the twenty-first century, have been a great catalyst for change in higher education. In times of transformation to Industry 4.0 the requirements to develop competencies 4.0 and the needed skills are becoming more and more demanding. Academia faces a number of challenges to tune programs and curriculums in order to satisfy the needs of the companies. New and innovative pedagogic approaches are needed not so much in the introduction and first level subject courses, where basic technical knowledge is delivered. However, in the third year, for the advanced subject and project courses they are critical for achieving the objectives of the courses and developing the competencies required by the industry of tomorrow. Pedagogical innovations that are experimented by many universities are alternatives to lecture, exploring the possibilities of active learning including project-based learning, inquiry-based learning, competency-based learning, scenario-based learning, adopt collaborative learning and share collective responsibility with the learners, and more. Technology supported innovations in higher education are described as the incorporation of technology into learning environments that can enhance knowledge, skills and attitudes. They are not merely the adoption of software and applications to manage the learning environment effectively, but they are enhancing the student's acquisition by introducing technological devices

2. Method

Flipped learning is an academic methodology wherein direct guidance moves from the gathering learning space to the individual learning space, and therefore the subsequent active gathering session is modified into a dynamic, intelligent learning condition where the teacher guides students, gives prompt feedback, discusses ideas. (see Figure 1)

Figure 1. Flipped learning compared to traditional face-to-face learning [Larmand A., 2021].

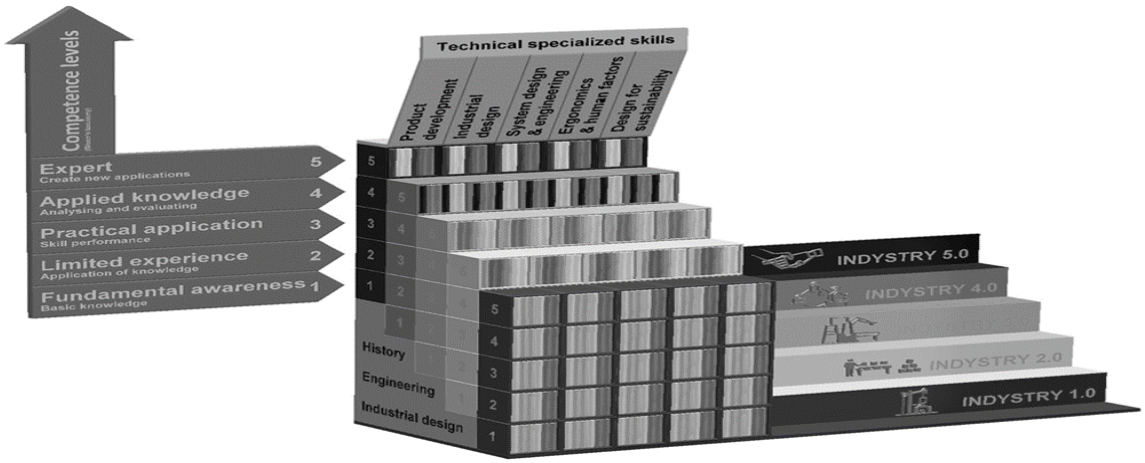


Flipped learning a purposeful approach to teaching and learning. It usually involves students reading text or watching videos outside of class and then taking part in a discussion, answering questions, writing essays, or completing projects once they return as a group. There is an important acronym when it comes to flipped learning. Often referred to as the four pillars of FLIP - keep a flexible environment, focus on the learning culture, deliver intentional content, and remain professional. Starting with flexibility - flipped learning allows teachers to try many different instructional modes and they often rearrange their teaching spaces to allow for different things. As for learning culture, educators need to flip from a teacher-centred model to a student-centred one. In addition, the fourth pillar - being a professional educator is more than it seems and involves greater demands in flipped learning. Teachers need to be constantly observing all students and providing relevant feedback. They also need to be reflective by assessing both student work and their own practice. No matter that is not teacher centred model, teachers are the essential factor in successful flipped learning. [Larmand A., 2021]

3. Example from Product design and development course for mechanical engineering students at LNU

In the figure below (see Figure 2), the knowledge and the competencies in the fields of mechanical engineering are presented in relation to the Bloom´s taxonomy and the chronological development of that knowledge following the industrial revolutions until nowadays and further.

Figure 2. Knowledge and competences in the field of mechanical engineering in relation to Bloom´s taxonomy and following the chronology of industrial revolutions.



One key subject in the field is Product development. Example with a course Product design and development will be presented further. It is one example of a subject that contributes to development of soft competences from the list of 2020 as follows: Complex problem solving, Critical thinking, Creativity, People Management (working in project groups), Coordinating with others, Judgment and decision-making, Cognitive flexibility. From other hand, the course is mobilising the specialized, technical and engineering skills acquired in the previous courses.

Product design and development course is a course from the last third year of the Mechanical engineering bachelor study and it is one of the last courses before the final project. The course is dedicated to not only give the students some knowledge and experience about Product design and development but it gives also a methodical base for successful degree projects. The course is project-based, with project task given by industrial companies. Working on the project students have the

feeling that they are solving problems from the reality. The examination is done through the report, written for the project, and the seminar sessions where students are presenting their work. A number of lectures are presenting to the students the theory needed to be applied in the project. From other hand, the course is mobilising the specialized, technical and engineering skills acquired in the previous courses.

During the pandemic time, when a shift from traditional teaching to online teaching was forced. After first two lectures, feedback from the students showed that lectures based on the active delivery from the teacher are not suitable to give via Zoom. Student are getting more passive when the life interaction is missing. The teacher who was giving the course had experience from previous redesign of the course with converting the course to active learning and student-centred learning with shifting some responsibilities for delivering knowledge content to students. Based on that experience and in discussion with the students it was decided that the approach to the online course Product design and development will be flipped learning. The presentations of the lectures, all the materials and the references to the textbooks were available for the student on the course page. They should get familiar with the lecture material in their own pace but before the corresponding steps in the project will be implemented. Then active sessions were planned for guiding, discussions and questions on the studied topic. For those sessions new type of lectures were prepared with guiding how to apply the theoretical step in the project. The students better appreciated such applicable approach. Those active sessions were done via Zoom in synchronous mode. Additionally, group project meetings were planned to be done with each project group separately in face-to face meetings. The result with applying Flipped learning during distance teaching was satisfactory, so it was decided to proceed with it in the face-to-face teaching.

In the sense of the first pillar "flexible environment", the students were given the opportunity to work in different environments. Theoretical material they have received for studding it in asynchronous mode, in their own pace. The guiding sessions were executed at the classroom as an active discussion to give the students confidentiality to apply the theory to the project. In the tutoring sessions, the teachers were meeting the project groups separately and often to give them feedback and as much as possible insights on what they have done in the project steps. The three seminars gave the students possibility to present their achievements and receive feedback from opposing group. Following the concept of the second pillar, students were transferred knowledge in a professional way of theoretical notes, guiding lectures and supporting materials to deliver the intentional content. Being intentional allows the learning to remain student-centred and active. When talking about the third pillar – "learning culture" the active class time was used for exploring topics in-depth and encouraging students to participate in and evaluate their learning. In this way, flipped learning can help students understand key concepts and procedures for solving problems. In addition, about the application of the fourth pillar – "to professional educator" – it could be stated that flipped learning sets higher demands on the educators to follow very close students learning and project work, to give continuous, relevant feedback and reflect not only the students work but also their own. Part of this reflection in the light of the demands for competences 4.0 is this paper.

4. Conclusion

The flipped learning method gave very good results in the course Product design and development. It provides students with an environment where they can learn and reflect according to their own needs and comfort. Flipped learning allows a student-centric learning approach rather than making a teacher, the primary and only source of information. With providing to every student relevant and accessible content, with available constant accesses and expert feedback the flipped learning approach really worked for the Product design and development course. It was decided to adopt the same approach in the post-pandemic period having the face-to-face mode of active sessions and group project tutoring done on campus.

References

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